



MED437  
KING SAUD UNIVERSITY



# Meninges, Ventricles, and CSF

Lecture (19)

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هذا العمل مبني بشكل أساسي على عمل دفعة ٤٣٦ مع المراجعة والتدقيق وإضافة الملاحظات ولا يغني عن المصدر الأساسي للمذاكرة

- **Important**
- **Doctors Notes**
- Notes/Extra explanation

{وَمَنْ يَتَوَكَّلْ عَلَى اللَّهِ فَهُوَ حَسْبُهُ}

# ■ Objectives

**At the end of the lecture, students should be able to:**

- ✓ Explain the cerebral meninges & compare between the main dural folds.
- ✓ Identify the spinal meninges & locate the level of the termination of each of them.
- ✓ Describe the importance of the subarachnoid space.
- ✓ Explain the ventricular system of the CNS and locate the site of each of them.
- ✓ Analyze the formation, circulation, drainage, and functions of the CSF.
- ✓ Justify the clinical point related to the CSF.

# Meninges



02:02

The brain and spinal cord (CNS) are invested by three concentric membranes/ layers:

1-The outermost layer is the **dura** matter.(fibrous)

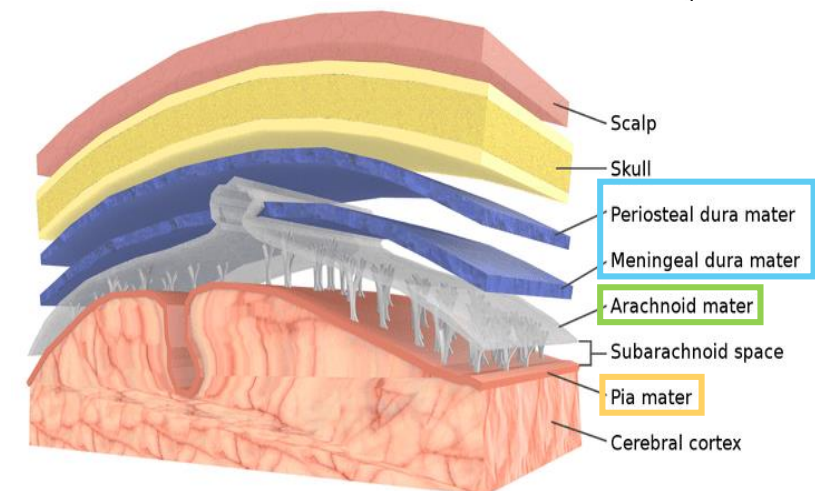
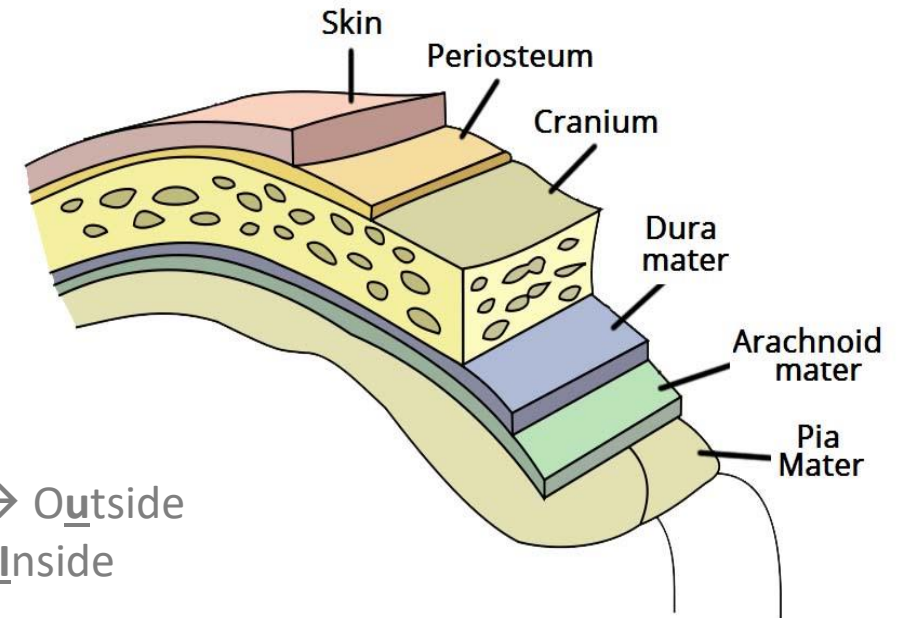
2-The middle layer is the **arachnoid** matter.(translucent)

3-The innermost layer is the **pia** matter.(translucent)

1- (The dura surround the brain and the spinal cord and is responsible for keeping in the CSF)

2- (from which it is separated by the subarachnoid space . The delicate arachnoid layer is attached to the inside of the dur and surrounds the brain and spinal cord.)

3- (Pia mater is a thin fibrous tissue that is impermeable to fluid. This allows the pia mater to enclose csf)



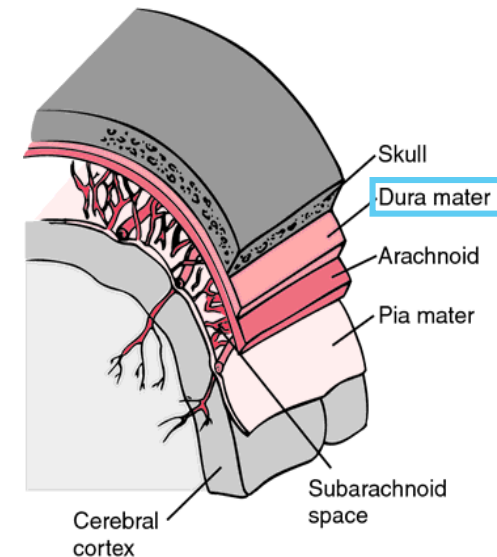
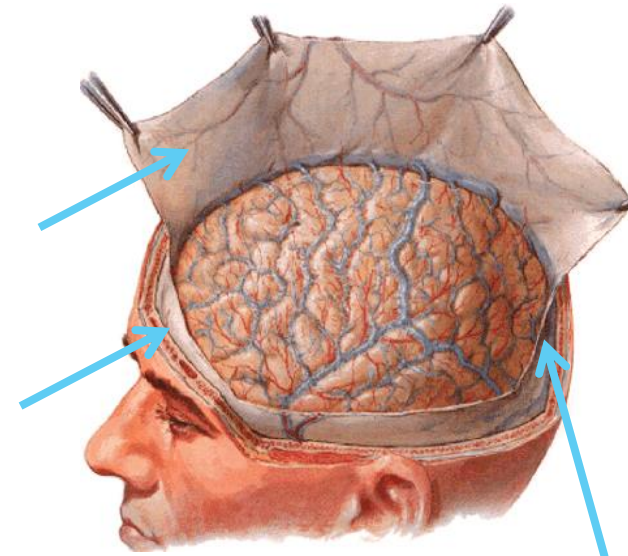
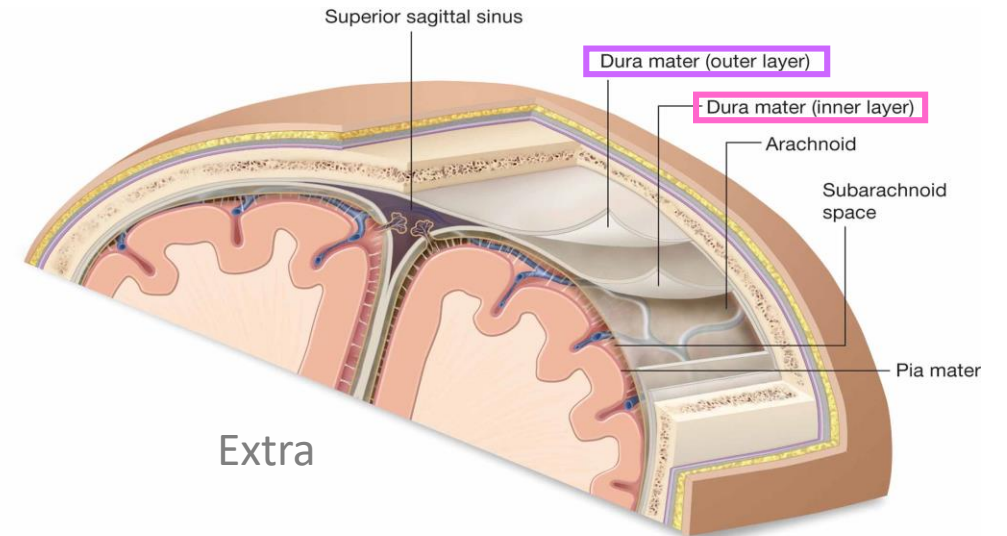
# Meninges

## 1- Dura Matter

- The **cranial dura** is a two layered tough, fibrous, thick membrane that surrounds the brain.
- It is formed of two layers\*;
  - **Periosteal**: attached to the skull\*\*.
  - **Meningeal**: folded forming the dural folds\* falx cerebri, and tentorium cerebelli.
- Sensory innervation of the dura is mostly from the three meningeal branches of:
  - The trigeminal (ophthalmic and maxillary)
  - Vagus nerves
  - C1 to C3 (upper cervical nerves).

\*they are adherent to each other, but in some areas they leave each other for forming the dural venous sinuses.

\*\*It is attached to the suture lines (above) and the foramina of exit of the crania nerves (in the base of the skull) عشان تثبت البرين



\*protect the brain

# Meninges

## 1- Dura Matter

\*anterior end attachment= crista galli  
Posterior end rest on tentorium cerebelli

\*\*anterior end: attached to anterior clinoid process  
The rest of it is attached to the inner aspect on the skull

Straight sinus (between  
the falx and tentorium )

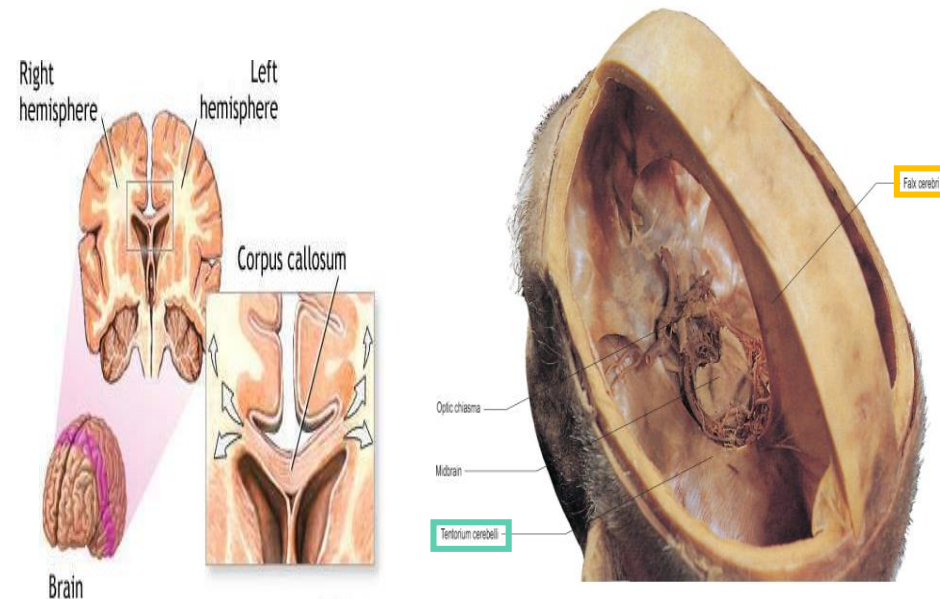
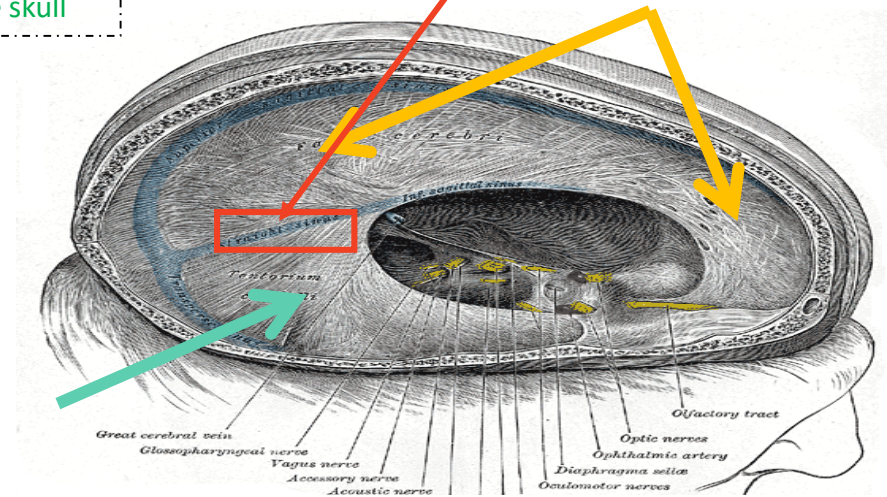
Two large reflection of dura extend into the cranial cavity;

### I. Falx cerebri\*;

- It is a vertical sickle shaped sheet of dura, in the midline
- Extends from the cranial roof into the **great longitudinal fissure** between the two cerebral hemispheres.
- It has an attached border adherent to the skull
- And a free border lies above the **corpus callosum**

### 2. Tentorium cerebelli\*\* (tent shape);

- A horizontal shelf of dura, lies between the posterior part of the **cerebral hemispheres** and the **cerebellum**.
- It has a free border that encircles the midbrain.
- Its superior surface in the middle line it is continuous (attached) with the falx cerebri, separated by the **straight sinus** .



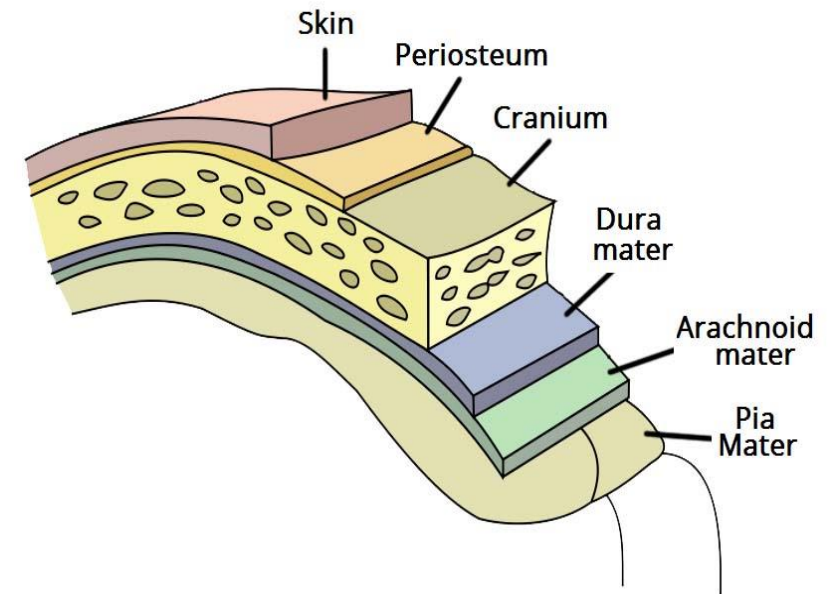
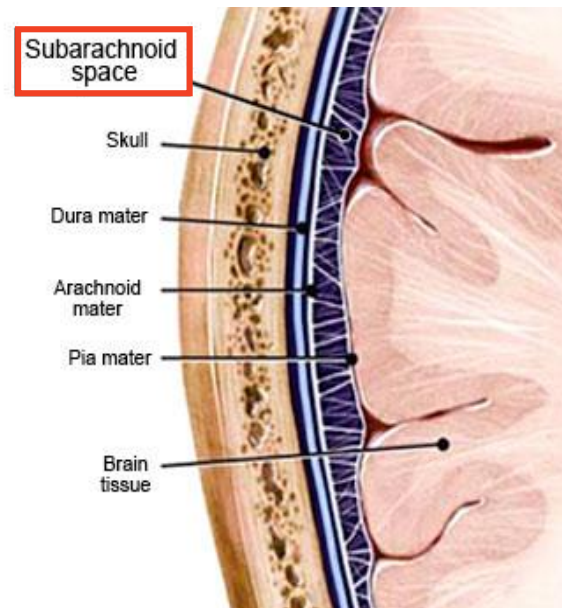
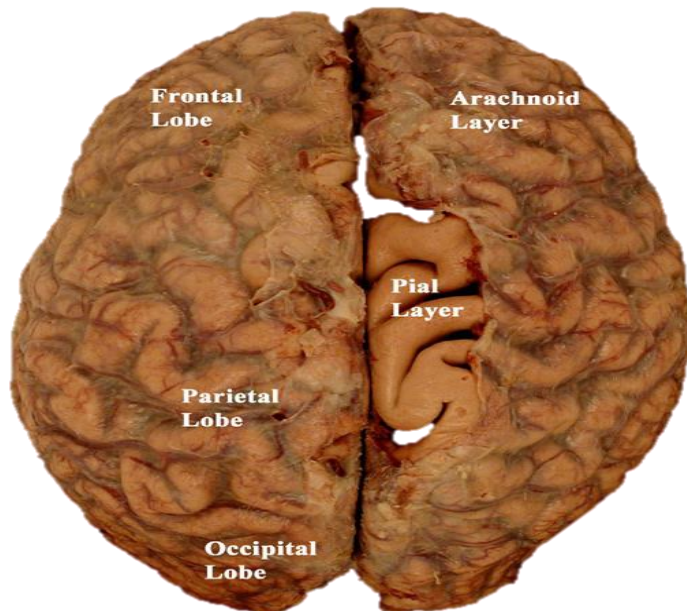
# Meninges

## 2- Arachnoid Mater

- is a soft, translucent membrane loosely envelops the brain.
- It is separated from the dura by a narrow subdural space.

## 3- Pia Mater

- is the innermost, thin, delicate & highly vascular membrane that is closely adherent (attached) to the gyri and fitted into the sulci
- Between the pia and arachnoid mater lies the subarachnoid space which contains; fibrous trabeculae, main blood vessels & CSF



# Meninges

## Subarachnoid Space

The subarachnoid space is varied in depth forming; **subarachnoid cisterns.**

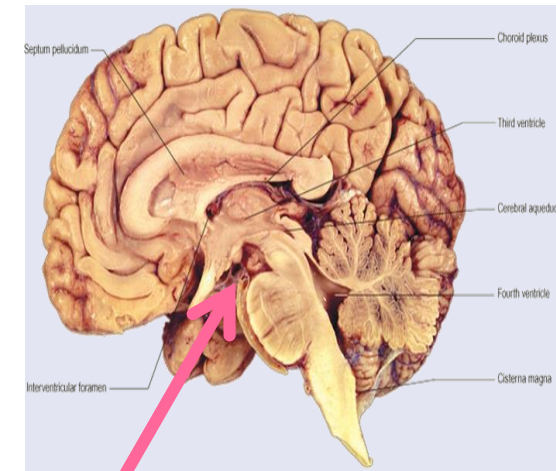
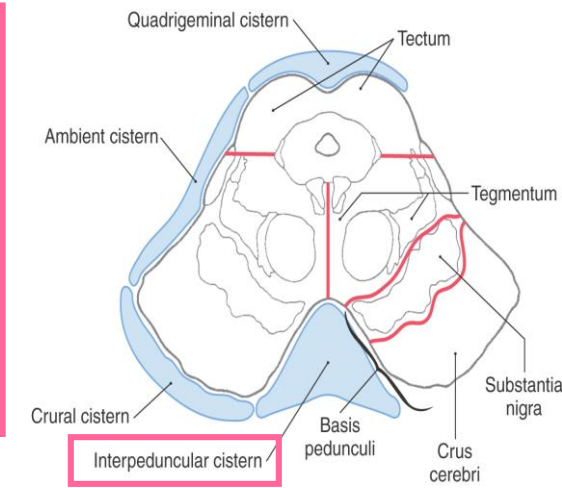
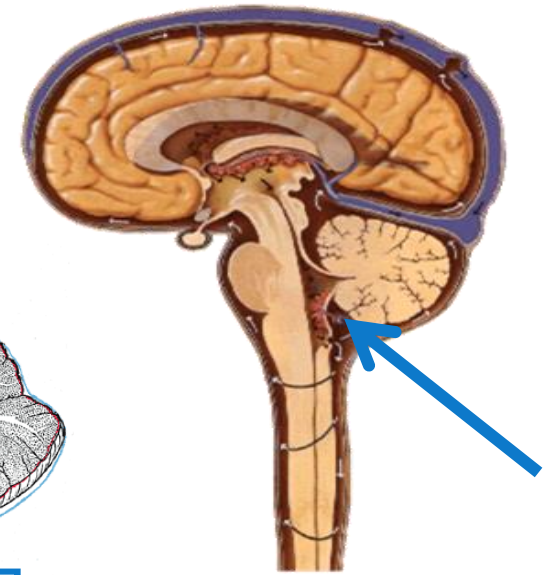
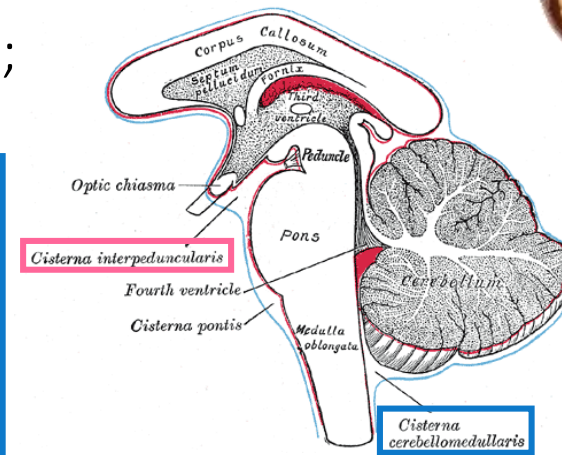
### 1- The cisterna magna, or cerebellomedullary cistern

- lies between the inferior surface of the cerebellum and the back of the medulla.
- from this cistern CSF flows **out** of the fourth ventricle via the 2 lateral apertures and median aperture.

### 2- Interpeduncular cistern;

- Is located at the base of the brain, where the arachnoid spans the space between the two cerebral peduncles of midbrain.
- It contains the optic chiasma & circulus arteriosus of Wills **and CSF.**

3- pontine cistern(around pons), it is not important as the first 2 cisterns



Cerebral peduncle= crus cerebri + substantia nigra

# Spinal Meninges

The spinal meninges are very similar to the cranial meninges with 2 differences: 1) the epidural space and 2) denticulate ligament

Just like the brain the spinal cord, is invested by three meningeal coverings: the **pia mater**, **arachnoid mater** and **dura mater**.

## Dura mater\*;

- the outer covering, **is a single**, thick tough fibrous membrane.
- It envelopes the cord loosely .
- It is separated from arachnoid matter by the **subdural space**, and from the bony wall of the vertebral canal by the **epidural space** (not found in the brain).

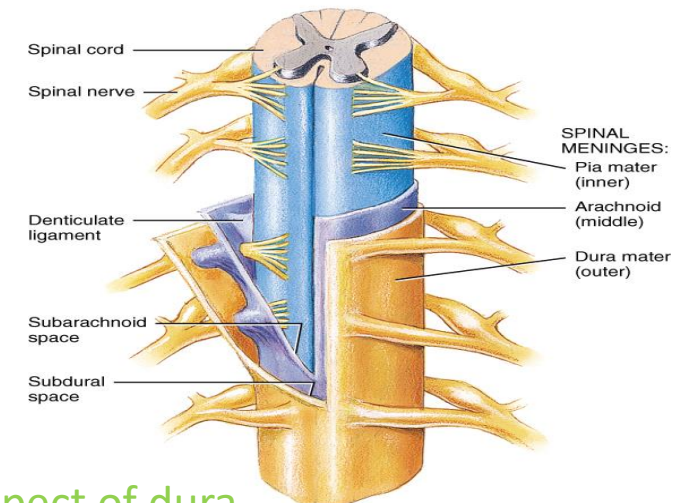
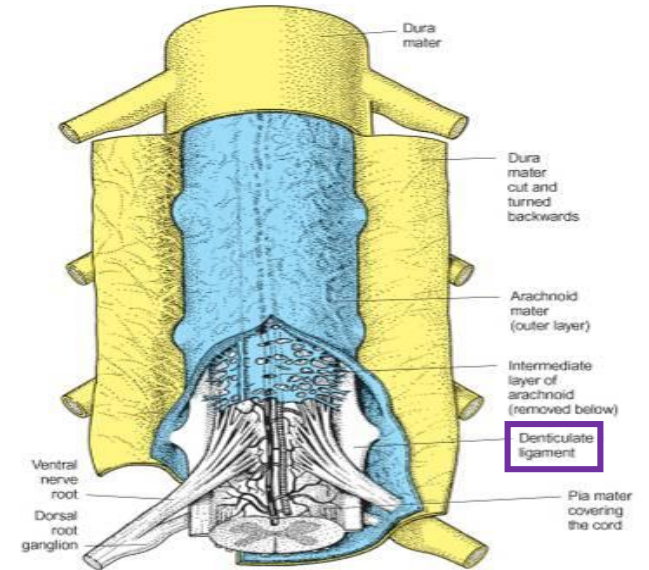
## Arachnoid matter;

- is a translucent membrane, lies between the pia and dura,
- Between it and pia lies the subarachnoid space **contains CSF**.

## Pia mater;

- Innermost covering, a delicate membrane closely envelops the cord and nerve roots.
- It is attached through the arachnoid to the dura by the **denticulate ligament**. \*

\*it is attached (superiorly) to the margin of foramen magnum, it continues with the spinal cord, after that it ends in S2 with the arachnoid matter.



\*The denticulate ligament (pia) passes through the arachnoid and attaches to the inner aspect of dura

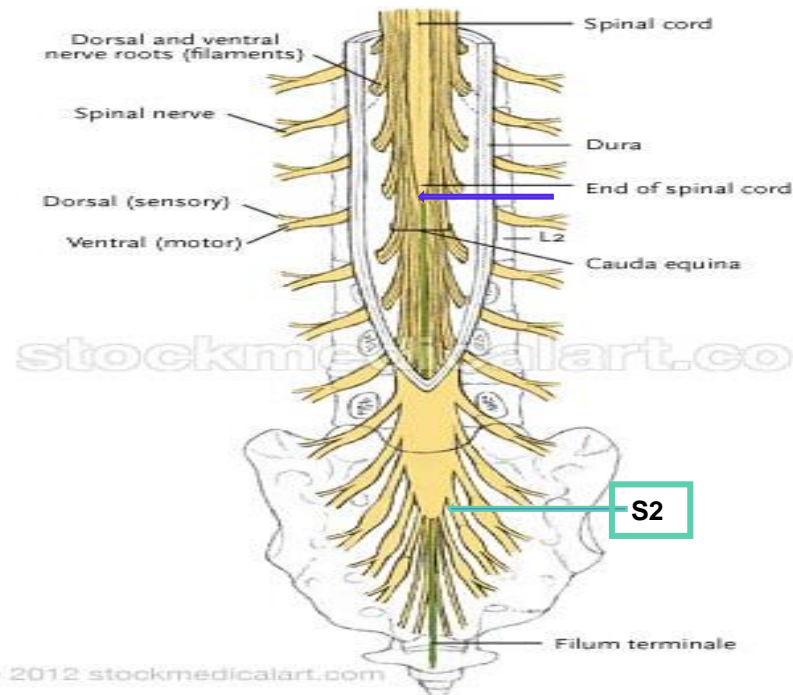
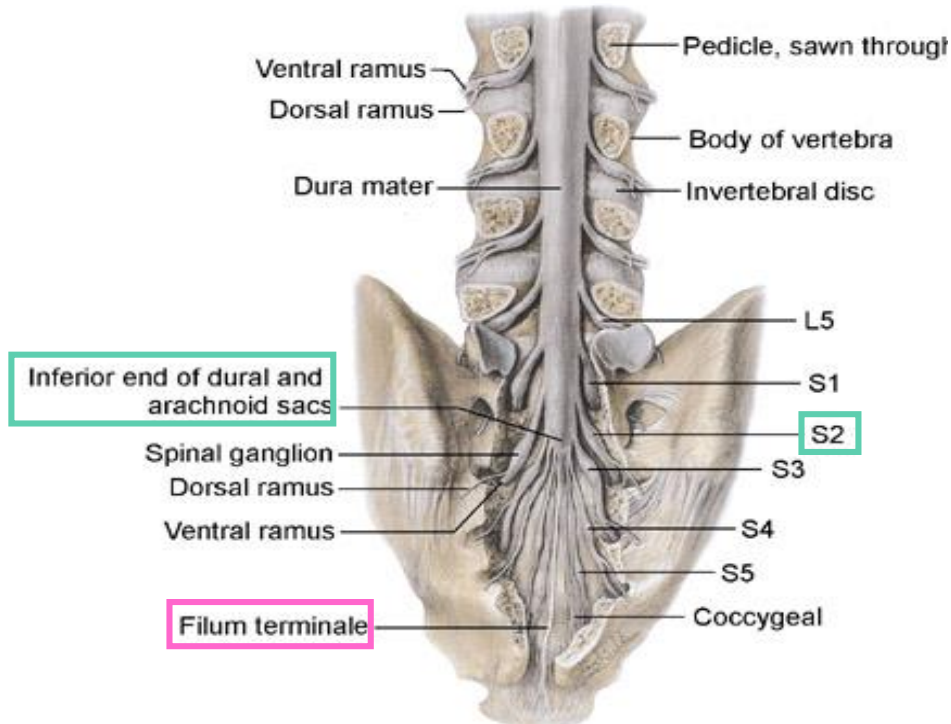


# Spinal Meninges

- **Spinal cord** terminates at level L1-L2.
- **Arachnoid** and **dural** and, **subarachnoid space**, continue caudally to S2.
- **Pia** extends downwards forming the **filum terminalis** which pierces the arachnoid and dural sacs and passes through the sacral hiatus to be attached to the back of the COCCYX.

Dr. Sanaa: Lumbar puncture is done between L3 and L4

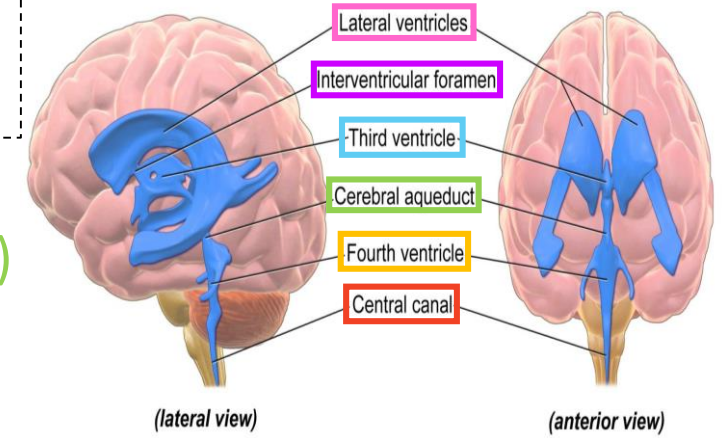
Dr. Essam: it is done between (L3-L4) or (L4-L5)



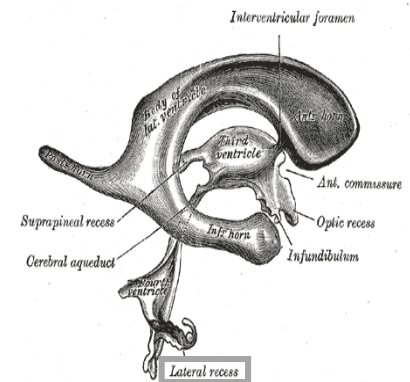
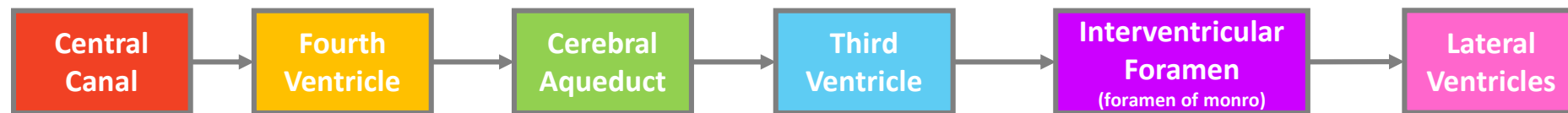
Structure	Ends at
Spinal cord	L1-L2
Dura, arachnoid, subarachnoid space	S2
Pia	Coccyx

# Ventricular System

-2 lateral ventricles in cerebral hemispheres  
-third ventricle in diencephalon  
-the fourth ventricle is between the cerebellum and the brainstem (pons and medulla)



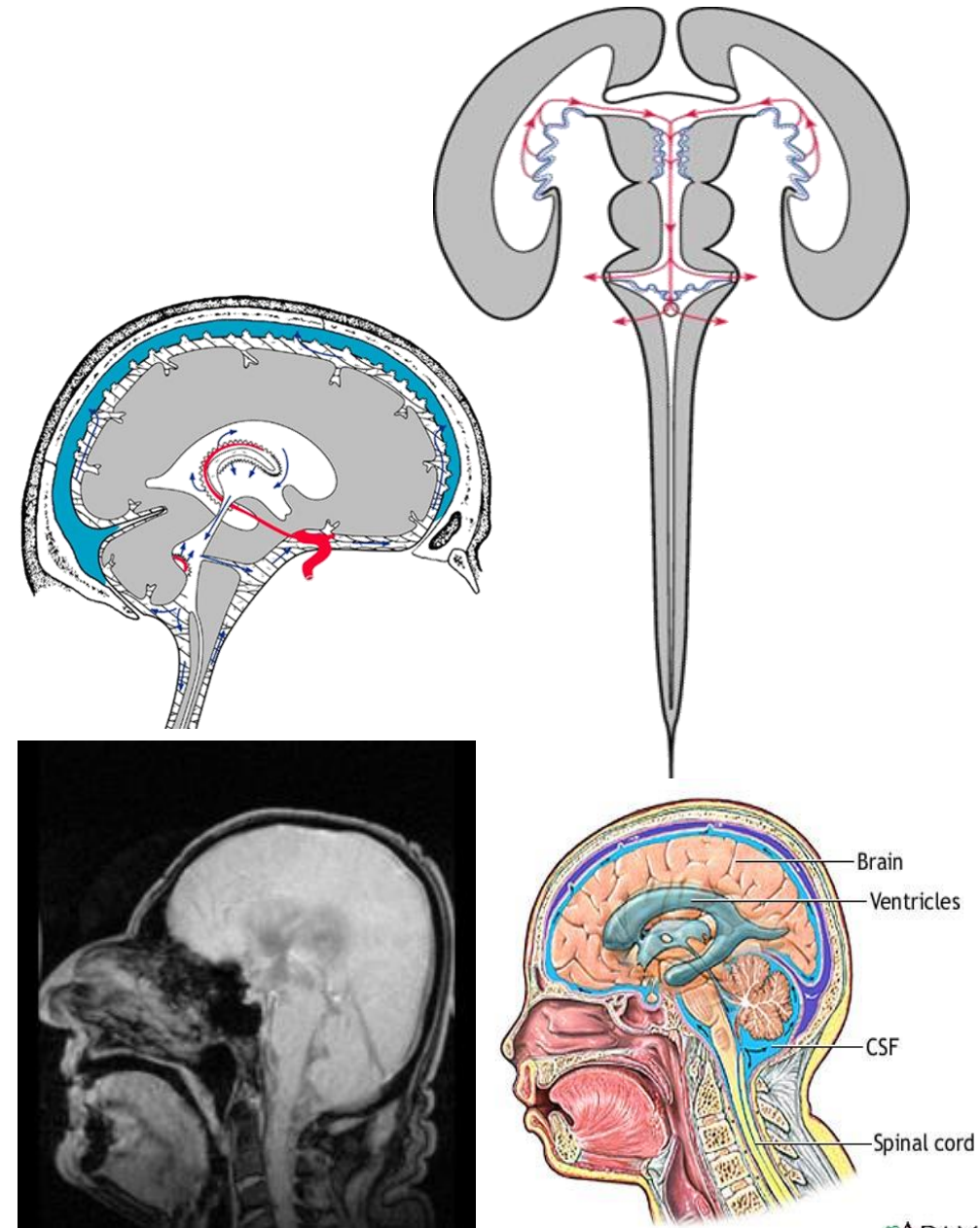
- Interconnecting channels within the CNS. (brain and spinal cord)
  - In the spinal cord; represented by the central canal.
  - Within the brain; a system of 4 ventricles is found.
- The central canal of the spinal cord is continuous upwards to the fourth ventricle.
- On each side of the fourth ventricle laterally, lateral recess extend to open into lateral aperture opening (foramen of **Luscka**), central defect in its roof (foramen of **Magendie**)\*
- The fourth ventricle is continuous up with the cerebral aqueduct, that opens in the third ventricle.
- The third ventricle is continuous with the lateral ventricle through the interventricular foramen (foramen of monro).



\*in the fourth ventricle there are 2 lateral recess which have an opening called foramen of luscka, there is another opening on the wall called foramen of magendie. These openings allow CSF to pass from the ventricular system to the subarachnoid space

# Cerebrospinal Fluid (CSF)

- Present in the ventricular system, together with the **cranial** and **spinal subarachnoid spaces**.
- It is colourless fluid containing little protein and few cells.
- It is about 150 ml. (125 – 150)
- It serves to cushion the brain from sudden movements of the head (**protects brain and spinal cord**)
- It is **produced by the choroid plexus** (cluster of capillaries), which is located in the lateral (largest), third & fourth ventricles.
- From lateral ventricle it flows: through the interventricular foramen to the third ventricle and, by way of the cerebral aqueduct, to the fourth ventricle.

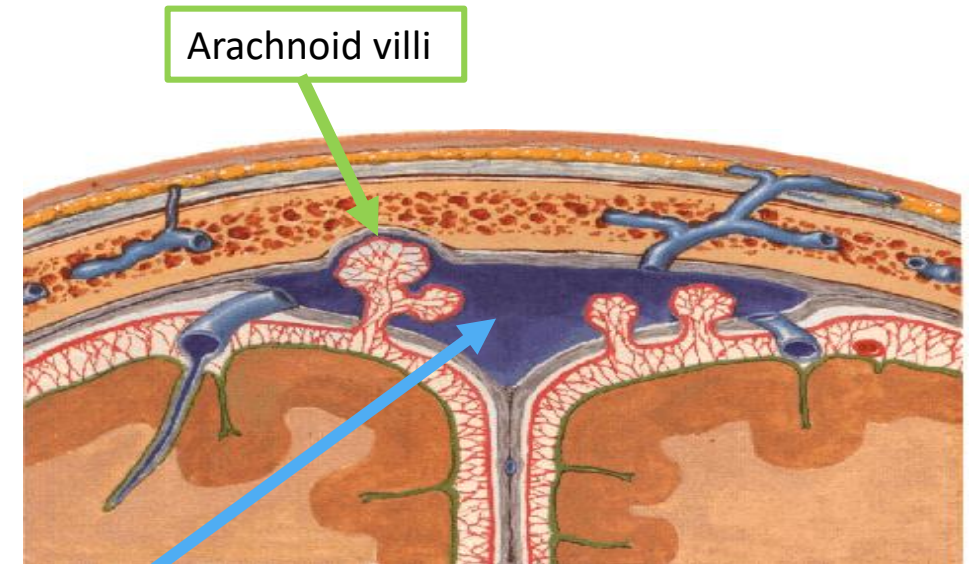


This picture is animated showing the pulsation of the CSF

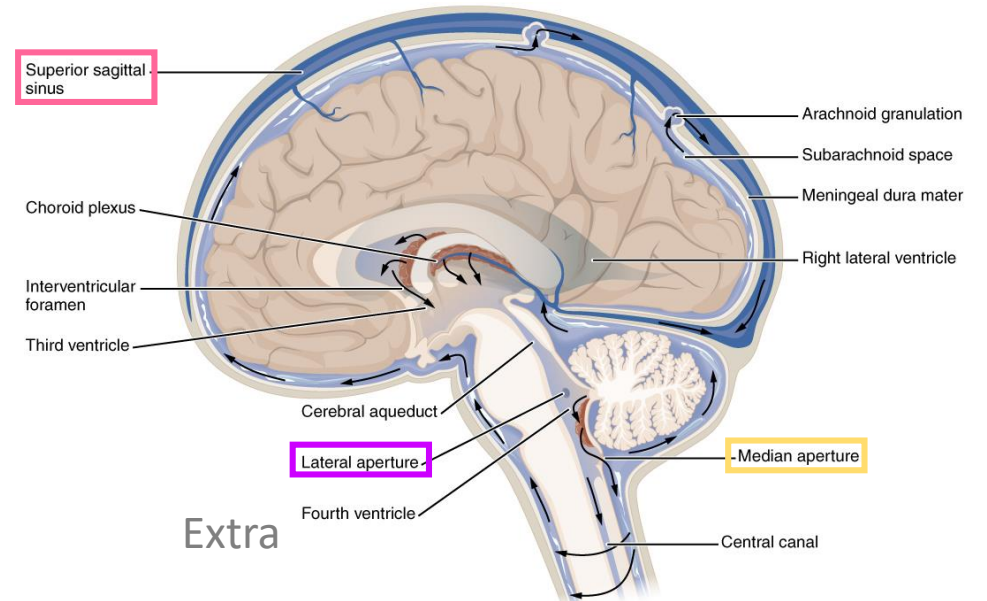
# Cerebrospinal Fluid (CSF)

- It **leaves** the ventricular system to **enter the subarachnoid space** through the three apertures of the 4th ventricle ;
  - median foramen of Magindi (to the central canal) &
  - 2 lateral foramina of Leushka.
- **Reabsorbed into the venous system** along;
  - arachnoid villi, and
  - arachnoid granulation (same as villi but bigger)
- that project into the dural venous sinuses, mainly superior sagittal sinus.

CSF is **made** in ventricles (choroid plexus), **circulates** in subarachnoid, and **drains** (reabsorbed) into venous (internal jugular vein) through dural venous sinus mainly superior sagittal sinus



dural venous sinuses.



# Cerebrospinal Fluid (CSF)

## Clinical Point

○ **Obstruction\*\*** of the flow of CSF leads to a rise in fluid pressure causing swelling of the ventricles (mainly the lateral ventricles) (**hydrocephalus\***).

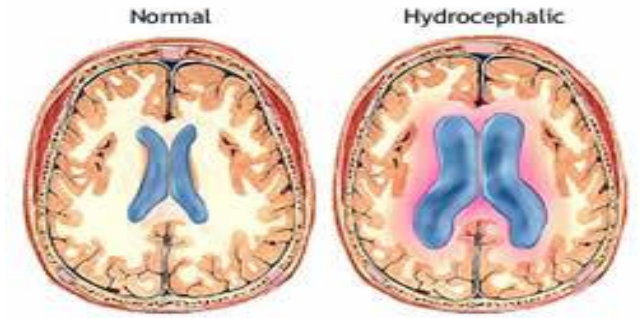
○ Causes:

**Only on the girl's slides**

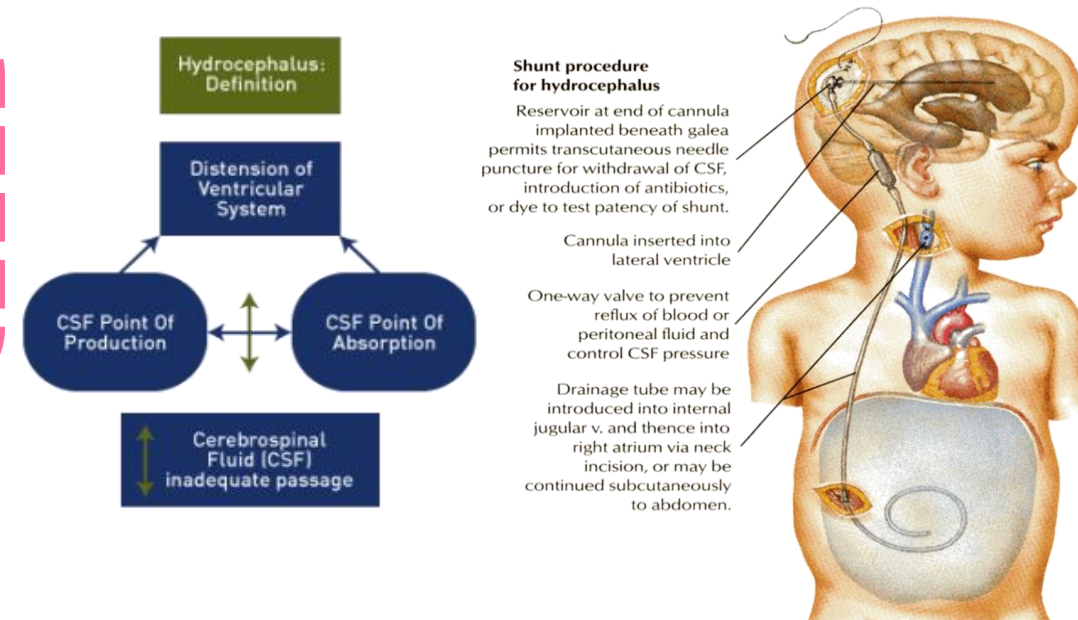
- Congenital (Arnold-chiari malformation) [learn more.](#)
- Acquired (Stenosis of the cerebral aqueduct by tumor OR Obstruction of the interventricular foramina secondary to tumors, hemorrhages or infections such as meningitis) .

○ Treatment: **Decompression** of the dilated ventricles is achieved by inserting a **shunt** connecting the ventricles to the **jugular vein** or the abdominal peritoneum.

\*Hydrocephalus is a condition in which there is an accumulation of cerebrospinal fluid (CSF) within the brain. This typically causes increased pressure inside the skull. Older people may have headaches, double vision, poor balance, urinary incontinence, personality changes, or mental impairment. In babies there may be a rapid increase in head size. Other symptoms may include vomiting, sleepiness, seizures, and downward pointing of the eyes.



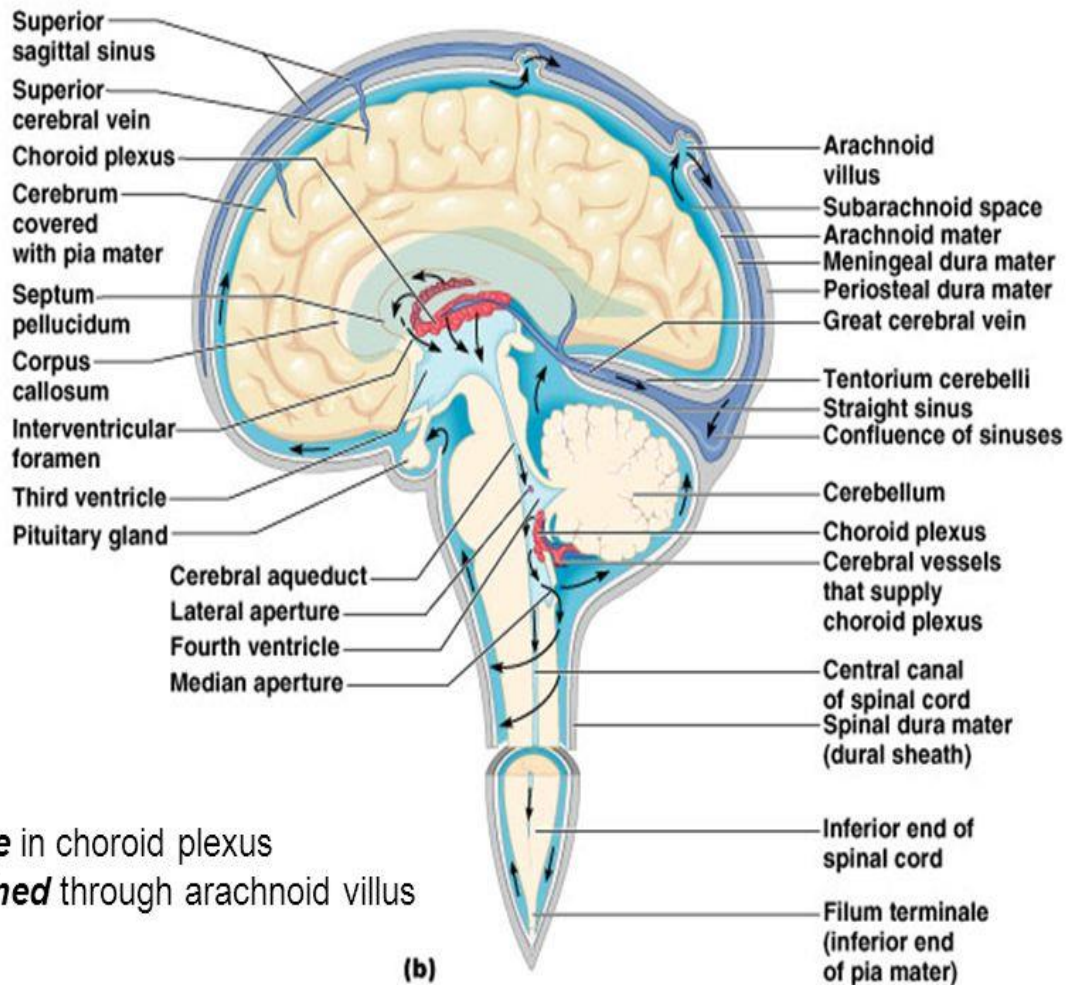
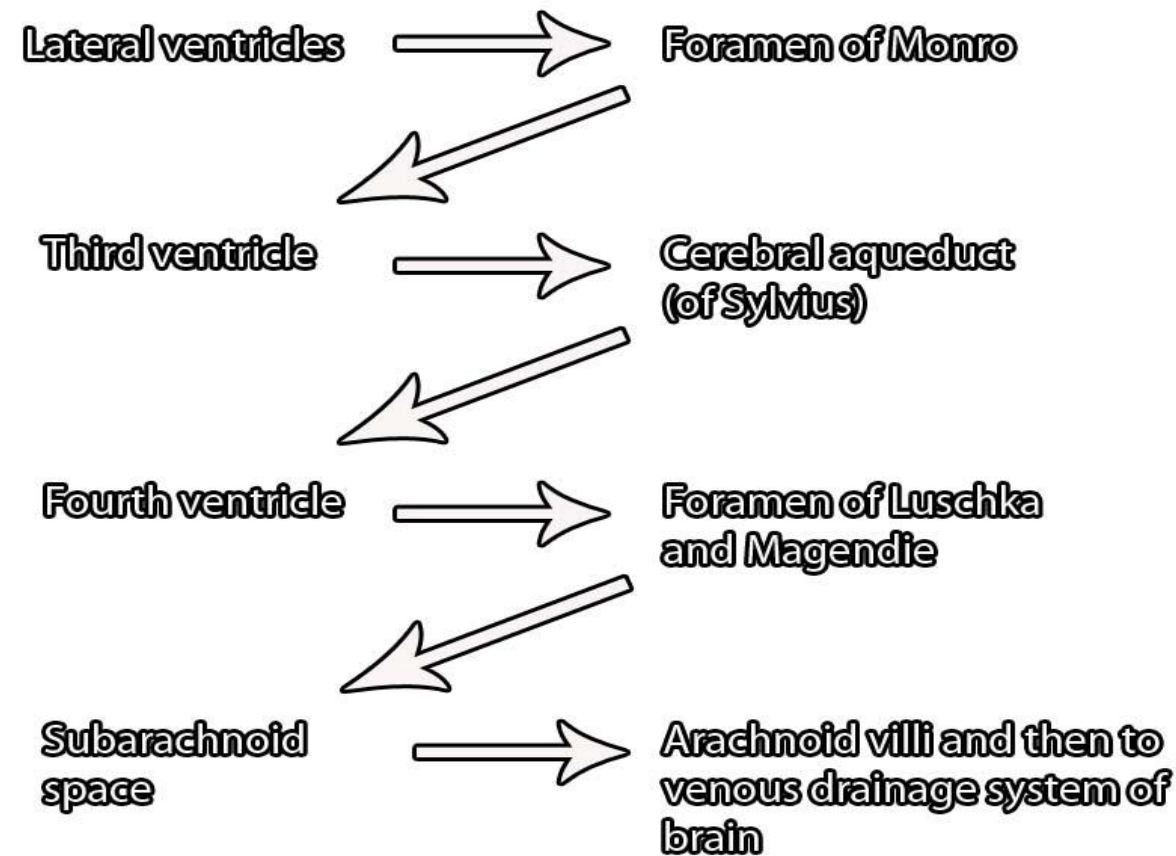
\*\*In children, it causes hydrocephalus  
In adults, it causes increased ICP causing severe headache



This slide is EXTRA for revision.

**CSF circulation:** through ventricles, median and lateral apertures, subarachnoid space, arachnoid villi, and into the blood of the superior sagittal sinus

## Cerebrospinal Fluid Pathway



CSF:

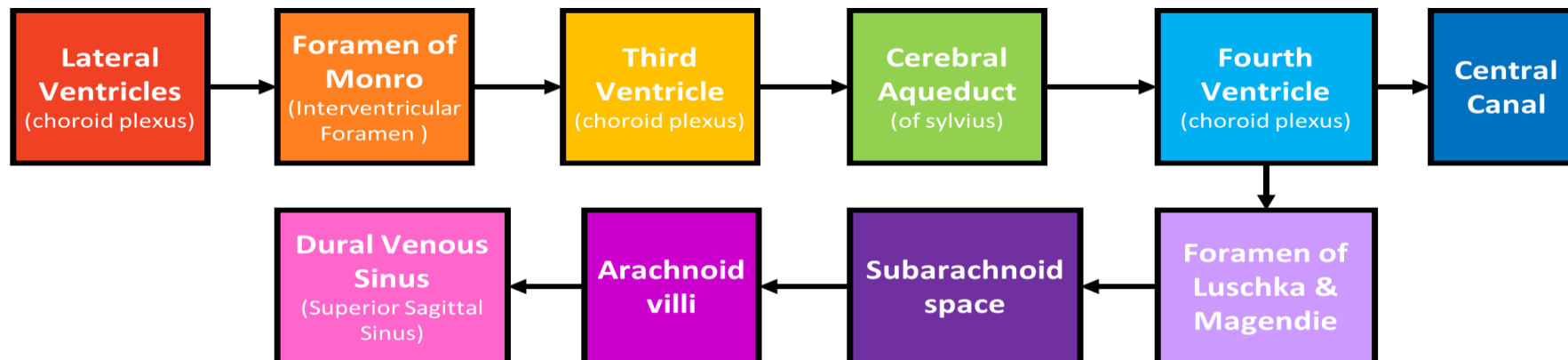
-**Made** in choroid plexus

-**Drained** through arachnoid villus

(b)

# Summary

- The brain & spinal cord are covered by **3 layers** of meninges :  
(1) dura, (2) arachnoid & (3) pia mater.
- The important **dural folds** inside the brain are the **falx cerebri** & **tentorium cerebelli**.
- CSF is produced by the choroid plexuses of the ventricles of the brain : lateral ,3rd & 4th ventricles.
- CSF circulates in the subarachnoid space.
- CSF is drained into the dural venous sinuses principally superior sagittal sinus.
- The **subarachnoid space** in the spinal cord **terminates at the 2nd sacral** vertebra while the spinal cord terminates at L1-L2
- Obstruction of the flow of CSF as in tumors of the brain leads to **hydrocephalus**.



# MCQs

**(1) Which one of these does NOT supply the dura?**

- A) Trigeminal
- B) Facial
- C) Vagus
- D) C1 – C3

**(2) Which of the following is a vertical sickle shaped sheet of dura?**

- A) Falx cerebri
- B) Tentorium cerebelli
- C) Corpus callosum
- D) Cisterna magna

**(3) Which of the following is only present in spinal meninges?**

- A) Cisterna magna
- B) Interpeduncular cisterna
- C) Dentate ligament
- D) Tentorium cerebelli

**(4) The subarachnoid space terminates at?**

- A) L1 – L2
- B) S1
- C) S2
- D) Coccyx

**(5) The ventricular system in the spinal cord is represented by?**

- A) Lateral ventricle
- B) 3rd ventricle
- C) 4th ventricle
- D) Central canal

**(6) The lateral ventricle opens into the 3rd ventricle through?**

- A) Foramen of luscka
- B) Foramen of magendie
- C) Foramen of Monroe
- D) Cerebral aqueduct

**(7) The CSF is reabsorbed into the venous sinus mainly through?**

- A) Superior sagittal sinus
- B) Inferior sagittal sinus
- C) Straight sinus
- D) Transverse sinus

**(8) Cerebrospinal fluid circulates in?**

- A) Ventricles
- B) Subarachnoid space
- C) Dural venous sinuses
- D) Epidural space

**(9) ?**


- A) B)
- C) D)

**(10) ?**

- A)
- B)
- C)
- D)



# Answers



(1) B

(2) A

(3) C

(4) C

(5) D

(6) C

(7) A

(8) B

(9) .

(10) .



# SAQ

**A patient presented to the hospital with headache and dizziness. After examination, the doctor diagnosed him with hydrocephalus.**

**(1) Describe the pathway of CSF with regard to 1- formation, 2- circulation, and 3- final drainage?**

1. The cerebrospinal fluid is formed by the choroid plexus in the ventricles. It flows from lateral ventricle to 3rd ventricle through interventricular foramen and then goes to 4th ventricle through cerebral aqueduct.
2. It passes from the 4th ventricle through 2 lateral foramina of leushka and foramen of magindi. Then it circulates in the subarachnoid space.
3. CSF drains through the arachnoid villi to the dural venous sinus (mainly superior sagittal sinus) and finally into internal jugular vein

**(2) What may the doctor do to relieve the hydrocephalus?**

Decompress the dilated ventricles by inserting a shunt connecting the ventricle to the jugular veins or abdominal peritoneum.

**(3) ?**



Good luck  
Special thank for team436 ❤️

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- References:
  1. Girls' & Boys' Slides
  2. Greys Anatomy for Students
  3. TeachMeAnatomy.com

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